Properties of Matter

2.1

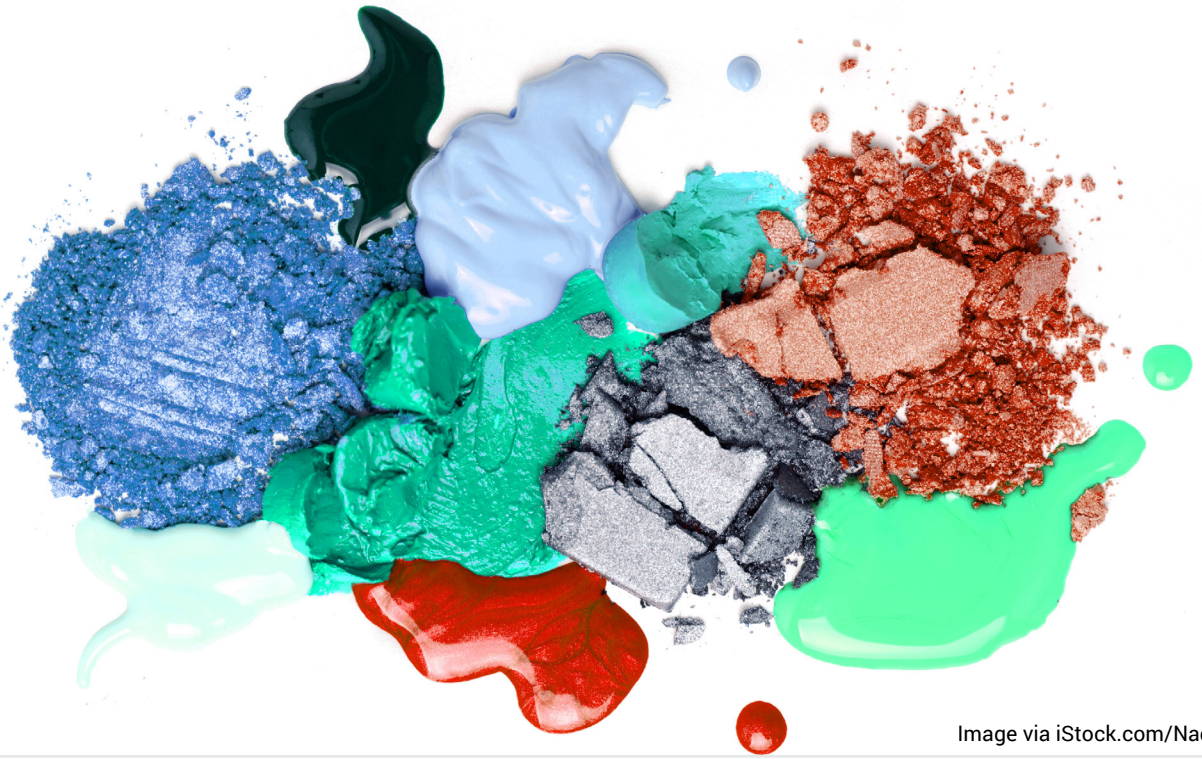

Image via iStock.com/NadinPanina

Anchoring Phenomenon

Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle.

Lesson Concept

Ask questions based on observations to find patterns of properties of different kinds of materials.

Investigative Phenomenon

Objects, such as crayons, birthday candles, lip balm, and other objects in the classroom, look and feel different from each other.

Standards

Refer to Appendix 2.1 for NGSS, CCSS-ELA, and California ELD standards.

Storyline Link

This unit serves as an introduction to the properties of matter, with the focus of building an understanding of properties of solids. As students engage in observations of solid matter around them, they have opportunities to connect their prior knowledge and language to the corresponding scientific vocabulary. This unit introduces students to the anchoring phenomenon: Materials are made from matter. We can observe misshapen objects, including crayons, lip balm, and a candle. (Note: throughout the unit, these three objects will be the focus; however, the properties of matter will be introduced via a variety of solids.) Investigating the properties of matter will help students generate the engineering problem. In addition, students are introduced to the development of an engineering problem by posing student-generated questions, such as, "How did the objects get this way?" or "How can we keep this from happening to the objects?" Students use their prior knowledge of daily interactions with matter as they begin by thinking about the everyday objects around them and the properties of the materials from which they are made. Students use prior knowledge from their five senses to make observations, find patterns in their observations, sort solid materials, and classify them by their properties. In the next lesson, students investigate the properties of liquids.

Throughout the lesson, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and emergent sense-making of phenomena.

Time

120 minutes

Part I	50 minutes	
	15 minutes	Engage
	25 minutes	Explore A
	25 minutes	Explain A
Part II	70 minutes	
	60 minutes	Explore B
	10 minutes	Evaluate

Materials

Whole Class

- ❑ Chart paper
- ❑ 2.1.C1: Student Question Chart
- ❑ 2.1.C2: Engineering Design Process
- ❑ 1 lip balm stick
- ❑ 1 birthday candle
- ❑ 1 misshapen crayon, lip balm stick, and birthday candle (already melted—see Preparation)

Group (Groups of 3)

- ❑ 1 regular crayon, lip balm stick, and birthday candle
- ❑ 1 misshapen crayon, lip balm stick, and birthday candle (already melted)
- ❑ Baggies
- ❑ Materials used to physically change objects; for example, hammers, rolling pins, cans of soup, piles of heavy books, or the leg of a chair, etc.
- ❑ 2 paper plates
- ❑ 8 solid objects (objects should include a variety of textures, colors, hardness, flexibility, shapes, and sizes). Select a variety from the following list:
  - ❑ Sandpaper
  - ❑ Plastic tangram pieces or other math manipulatives
  - ❑ Cotton balls or cotton swabs
  - ❑ Foam sheets and/or yarn
  - ❑ Buttons with and without texture
  - ❑ Metallic objects and/or aluminum foil
  - ❑ Fabrics such as lace, corduroy, velvet, wool, nylon (raincoat), denim, fleece, and/or felt
  - ❑ Sticky/stretchy frogs and/or rubber bands
  - ❑ Seashells with a variety of textures
  - ❑ Rocks of different textures (volcanic rocks)

Individual

- ❑ Goggles (for safety)
- ❑ Science notebook
- ❑ Pencils
- ❑ Sticky notes
- ❑ 2.1.H1: Engineering Planning Sheet

Advance Preparation

1. Melt the crayons, birthday candles, and lip balm stick before beginning the lesson. One effective method for melting is to place the objects on Teflon foil in the oven at 170 degrees until they melt. See How to Melt Crayons (https://www.wikihow.com/Melt-Crayons) for three other possible methods.
2. Assemble the 2 baggies — one with the misshapen crayon, lip balm stick, and birthday candle and one with the regular crayon, lip balm stick, and birthday candle ready to distribute to each group.

3. Gather materials for students to use to physically change the objects: hammers, rolling pins, cans of soup, piles of heavy books, leg of a chair, etc.
4. On chart paper, prepare the **2.1.C1: Student Question Chart**.
5. Prepare the **2.1.C2: Engineering Design Process** chart for classroom viewing.
6. Make copies of **2.1.H1: Engineering Planning Sheet**. Glue the **2.1.H1: Engineering Planning Sheet** into each student's science notebook for use throughout the unit.

Procedure

Part I

Engage (15 minutes)

Ask questions and observe the properties of a material.

TEACHER NOTE

The Engage stage of this learning sequence is intended to 1) generate students' questions about the phenomenon (misshapen objects), 2) help students access their prior knowledge about the five senses and the ways the five senses are used to make observations, and 3) demonstrate that investigating the properties of matter will help students generate the engineering problem. Recalling how we make observations will help students with their investigation plans in the Explore stage of the learning sequence.

1. Display the misshapen objects from one baggie for the whole class. Ask the students to observe the misshapen objects, using prompts such as, "What do you see? What do you think about what you see? What does it make you wonder?" Have students pose questions about what they see and wonder. Expected Students Responses (*ESRs*) may include the following questions from students: *What happened to the objects? Why do they have such a funny shape? How can we keep it from happening again?* Chart student questions on **2.1.C1: Student Question Chart**.

TEACHER NOTE

Do not use the vocabulary *melted* and *unmelted* during the Engage. This lesson helps students to eventually develop an understanding that matter exists as either a solid or a liquid depending upon temperature.

2. Distribute to each group of three students a baggie with the misshapen items and a paper plate. Have them lay the objects on the plate and take a closer look. Ask students to think-pair-share more questions about the misshapen objects, using their senses of touch and smell, such as: "What do you feel when you touch the objects? How do the objects smell? What is the same about the objects? What is different about the objects? What does it make you wonder? "
3. Chart additional student questions about the misshapen objects on **2.1.C1: Student Question Chart**. *ESRs: Why do the objects look different? How did the objects change shape? Can I still use the objects? Can we change the colors? Where were the objects? Do the objects still smell the same? How did they look before they changed? Can the changed objects go back to being the way they were? Why did the objects spread out? Did the objects melt? Was the lip balm left out in the sun?*

TEACHER NOTE

Accept questions about melting. Eventually, the students will discover that the objects changed shape due to a temperature change.

TEACHER NOTE

Retain the **2.1.C1: Student Question Chart**. These questions will drive instruction and help students identify the engineering problem. Subsequent lessons will address some of the student questions from steps 1–3. Throughout the unit, students will collect evidence via experiences with the investigative phenomenon (objects, such as crayons, birthday candles, lip balm, and objects in the classroom, look and feel different from one another). This will help students develop better explanations for the anchoring phenomenon and continue to build on their understanding of the crosscutting concept of patterns from previous grade levels.

4. Referring to the student-generated questions, inform students that scientists ask questions based on observations to find out more information about the world. Let students know that we will be exploring some of their questions in the next several days and that scientists often start investigating questions by observing and recording their observations. Scientists ask questions, and engineers solve problems.

TEACHER NOTE

Refer to **2.1.H1: Engineering Planning Sheet**. In addition to observing the properties of matter, students are beginning to identify the engineering problem, which is the **Ask** phase of the design process.

5. Distribute **2.1.H1: Engineering Planning Sheet** and have student put it in their science notebook. Say to students, "Let's think like engineers." Point out the **2.1.C2: Engineering Design Process** chart and review the steps in a design process. Point to the **Ask** and say, "What's the problem with the three misshapen objects?" *ESRs: The birthday candles won't work. I can't put those candles on a cake. I can't use the lip balm on my lips. I can't color with those crayons.* Have students record their engineering problem in the Ask section of the **2.1.H1: Engineering Planning Sheet** in their science notebooks.

Explore A (25 minutes)

Carry out an investigation to observe properties of different kinds of materials.

6. Have students select multiple questions from the **2.1.C1: Student Question Chart** and help them to discuss which questions they might be able to solve with an investigation. Select two questions similar to the following from the **2.1.C1: Student Question Chart**: *How did they look before they changed? How did they change?* or other questions that students want to investigate. Say to students, "Let's find out!"

7. Elicit student suggestions about how we could find out how the misshapen objects looked before and how they changed. *ESRs: We can look at a regular one (crayon, birthday candle, and lip balm to see what they looked like before. We have to try to break them. We have to bend them. We have to smash them.*
8. Distribute the baggie with with the undamaged candle, and lip balm. Allow time for students to decide how to make the regular objects look misshapen (i.e., to physically change the objects). Have a variety of materials available for students to select and use (e.g., hammers, rolling pins, cans of soup, piles of heavy books, leg of a chair, etc.). Have students record their ideas prior to using the materials that are provided. Then, have students work in groups of 3 to investigate their ideas.
9. Allow time for students to carry out their plans. Display the original bag with the misshapen objects. Ask, "With your plan, did you get your objects to look like the misshapen ones?" *ESR: No!*
10. Add the *No!* to the **2.1.C1: Student Question Chart**. Ask students, "What do you think we should do next?" *ESRs: I tried hitting it, now I want to put something heavy on it. I tried something heavy, now I want to try rolling something on it.*
11. Allow time for students to reconsider how to make the regular objects look misshapen (i.e., to physically change the objects). Have students suggest other materials in the classroom they might use in addition to hammers, rolling pins, cans of soup, piles of heavy books, or chair legs. Allow time for students to conduct their investigations.

Explain A (10 minutes)

Observe properties of different kinds of materials.

12. ▶ Have students write or draw their observations of the changed misshapen objects in their science notebook. Encourage students to use their own language related to describing the strength, flexibility, hardness, and texture of the objects. *ESRs: I could not get the regular ones to look like the funny ones. When I hit it, the crayon crumbled. When I rolled it, the birthday candle broke. When I hit it, the lip balm broke and smeared.*

TEACHER NOTE

▶ Use what students have written or drawn in their science notebook as a formative assessment of their emerging understanding of properties of solids (strength, flexibility, hardness, and texture). Accept student language that approximates the language we want students to use when they understand the concept of properties of solids. Explore B has a two-pronged emphasis. If students do not have a thorough understanding of the properties of solids, Explore B may be used to develop an understanding of the properties of solids. If students do have understanding without knowing the vocabulary, Explore B can be used to develop scientific vocabulary.

Part II

Explore B (60 minutes)

Carry out an investigation to observe and classify patterns of properties of different kinds of materials.

13. While reviewing the student-generated observations in step 12, ponder with the students: "I wonder if there are things other than crayons, birthday candles, and lip balm that we can make observations about?" Ask students to brainstorm with their group other things they could observe in the classroom. Circulate to listen to objects students mention.

14. Ask each group to share one object they brainstormed. Chart student responses. *ESRs: markers*, *glue bottles*, *glue sticks*, *balls*, *craft sticks*, *pencils*, etc.

15. Have students work in pairs to investigate objects they brainstormed in the classroom and/or objects provided by you (including, but not limited to sandpaper, math manipulatives, cotton balls, yarn, buttons (with and without texture), aluminum foil, a variety of fabrics, rubber bands, and/or seashells with a variety of textures).

16. Encourage students to explore the objects by asking the following questions:

    - What does the object feel when you touch it?
    - How does the object smell?
    - What is the same about the objects?
    - What is different about the objects?
    - What does it make you wonder?

17. Allow time for students to explore the objects they selected. Have students discuss the similarities and differences in the objects they selected. Circulate among the groups to listen to the different words students use to describe the objects.

> **TEACHER NOTE**
>
> As you circulate among the groups, jot down words you hear the students use related to the properties of matter. Use the students' prior knowledge and language to support the development of student understanding of the properties of objects and the anchoring phenomenon: Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle.

18. Have students sort the objects using the patterns (similarities and differences) they noticed in their observations. Have students explain to their group how they sorted the objects. Then have them record and label their sorts in their science notebook. Encourage students to label their grouped objects with a word or phrase that describes what is similar about the objects in the group. Once students have recorded their first sort, encourage student groups

to find a second way to sort the same objects. Have students record and label this sort in their science notebook as well. Alternatively, students can sort by one similarity, such as "things that are soft" and "things that are not soft." After recording this sort, ask students to choose another similarity to sort by.

19. Ask students to choose one sort to leave on their workspace with their science notebook open. Have student groups walk around the room (gallery walk) to observe other groups' sorts. Encourage student-to-student interaction as student groups stop at each other's workspaces, and have students use their observations to explain the sorts of other student groups. As needed, scaffold student language with the use of sentence frame such as:

    All of the items in this group are/have ___, while all of the objects in this group are not/do not have ___.

20. During the gallery walk, circulate and facilitate conversations that lead student groups to recognize the use of patterns of similarities and differences in the properties of the objects. Select some students to share with the whole class their ideas about the patterns they noticed in their observations.

21. Have students bring their science notebook and one object they explored to the carpet. Have one student share his or her object and describe it. Have another student do the same thing. If it's like the one the student before described, add it to the pile. Go around until every student has had a turn, and all objects are sorted. Now, review the properties of the objects.

TEACHER NOTE

Students often will name an object rather than describe it. Redirect their thinking by saying, "Yes, that's what we call that object. Now think about how you described it to us." A possible exchange between you and your students might go like this:

Teacher: "Explain why you put that object in that pile."

Student: "They are all markers."

Teacher: "Yes, we call them markers. Now think about how you described it to us and use those words to tell us why they belong in that group."

Student: "The case is smooth, hard, and round. I cannot bend it."

22. Distribute sticky notes to students and have each student write one word that describes their object. Select students to come to the board, each with one sticky note. One at a time, have each student read the descriptive word on the sticky note and place it on the board.

23. Encourage students to "clump" similar ideas as the sticky notes are placed on the board, noticing patterns of similarities and differences in the descriptive words.

24. As students group sticky notes using their own words to discuss why they belong together, further develop the idea of *properties* by introducing the property term that describes each "clump." For example, as students say *rough*, *smooth*, *fuzzy*, and *bumpy*, share that the word *texture* can be used to describe this property of materials, and facilitate students grouping all texture property words together. Write the word texture on the board or chart so that it is visible for students to refer to later. Take student words and relate them to the scientific vocabulary of the properties of solids (*texture*, *hardness*, *strength*, *flexibility*).

25. Continue this process with all students and their sticky notes, introducing and recording property terms as they apply. To further develop property categories, have students suggest other descriptive words that could fit each property category.

> **TEACHER NOTE**
>
> As students figure out properties for each clump of sticky notes, facilitate categorizing based on patterns in student observations to include the following properties: color, texture, hardness, flexibility, shape, and other properties.

Evaluate (10 minutes)

Observe and classify patterns of properties of different kinds of materials.

> **TEACHER NOTE**
>
> Throughout the Matter Unit, a 5E model will be employed; however, at the end of Lesson 1: Properties of Matter, there is no Elaborate because this phase of the 5E model will occur later in this Matter Unit.

26. ▶ Remind students of the anchoring phenomenon: Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle. Provide an opportunity for students to add to or revise their observations of the anchoring phenomenon in their science notebook. Encourage students to use the new descriptive words they have just learned.

27. If needed by students, provide the following sentence frames:
    - The texture of the _____ is _____.
    - The strength of the _____ is _____ than the _____.
    - The hardness of the _____ is _____ than the _____.

28. Ask students if anything they just did would help the objects go back to their original shape. Refer to the **2.1.C1: Student Question Chart** and the engineering question, "How can we keep this from happening?" *ESRs: Don't drop them. Don't break them. Don't hit them. Put bubble wrap around them. Keep them safe*. Point to the **Imagine** section of the **2.1.C2: Engineering Design Process** chart and have students add their ideas to the **2.1.H1: Engineering Planning**

TEACHER NOTE

At this point in the lesson, students have been exposed to the anchoring phenomenon; however, they have not explained the anchoring phenomenon. Lesson 1: Properties of Matter builds to an understanding that in order to know if something has changed, one must know what it was like before it changed. Understanding the properties of solids will help students describe changes that resulted in the misshapen objects and formulate an engineering problem.

Sheet in their student notebook.

References

WikiHow. (2020, June 14). How to Melt Crayons. Retrieved June 29, 2020, from https://www.wikihow.com/Melt-Crayons

Toolbox Table of Contents

Student Question Chart

Questions

Engineering Design Process

Engineering Design Process

Ask:	Identify a design problem.
Imagine:	Collaboratively brainstorm multiple ways to generate and solve a design problem.
Plan:	Create a step-by-step solution, on paper, to solve a design problem.
Create and Test:	First attempt to actualize the plan to solve a design problem.
Improve:	Use the data you collected during the test to improve your plan.
Re-create:	Next attempt to improve your solution to a design problem. Repeat until a solution is achieved.

Engineering Planning Sheet

Ask: What is the problem?

Write it:

_____

_____

Imagine: Brainstorm ways to solve the problem.

-
-
-
-
-
-

Plan: What is your step-by-step solution to solve the problem?

Draw a diagram:

Engineering Planning Sheet (continued)

First,

Next,

Last,

Materials you will need:

Create and Test: This is your first attempt to solve the problem:

Follow your plan and make a model. Then test your model to see if it solves the problem.

Engineering Planning Sheet (continued)

Improve: Use the data you collected during the test to improve your plan.

What works?

What doesn't?

How can you make it better?

Re-Create: This is your next attempt to improve your solution to the problem.

Revise your plan and make a model. Then test your model to see if it solves the problem.

Appendix 2.1

Properties of Matter

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
2-PS1-1	Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]
2-PS1-2	Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.* [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [*Assessment Boundary: Assessment of quantitative measurements is limited to length.*]

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)
Asking Questions ~~and Defining Problems~~
• Ask questions based on observations to find more information about the natural and/or designed world(s).
Planning and Carrying Out Investigations
• Make observations (firsthand or from media) ~~and/or measurements~~ to collect data that can be used to make comparisons.
Obtaining, Evaluating, and Communicating Information
• Communicate information ~~or design ideas and/or solutions~~ with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and /or design ideas.
Analyzing and Interpreting Data
• Record information (observations, thoughts, and ideas).
• Use observations (firsthand ~~or from media~~) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.

DISCIPLINARY CORE IDEAS (DCI)
PS1.A: Structure and Properties of Matter
• **Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature.** Matter can be described and classified by its observable properties.
ETS1.A: Defining and Delimiting an Engineering Problem
• Asking questions, making observations, and gathering information are helpful in thinking about problems.

Appendix 2.1

CROSSCUTTING CONCEPTS (CCC)
Patterns
• Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Common Core State Standards (CCSS)

CCSS ELA WRITING
CCSS.ELA-LITERACY.W.2.8
Recall information from experiences or gather information from provided sources to answer a question.
CCSS ELA SPEAKING & LISTENING
CCSS.ELA-LITERACY. SL.2.1
Participate in collaborative conversations with diverse partners about *grade 2 topics and texts* with peers and adults in small and larger groups.
CCSS.ELA-LITERACY. SL.2.6
Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification.
CCSS ELA LANGUAGE
CCSS.ELA-LITERACY. L.2.3
Use knowledge of language and its conventions when writing, speaking, reading, or listening.

California English Language Development (ELD) Standards

CA ELD		
Part 1.2.1 Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics		
EMERGING	EXPANDING	BRIDGING
P1.2.1 Contribute to conversations and express ideas by asking and answering *yes-no* and *wh-* questions and responding using gestures, words, and learned phrases.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, and adding relevant information.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, adding pertinent information, building on responses, and providing useful feedback.
In addition to the standard above, you may find that you touch on the following standard in this lesson as well:		
P1.2.5 Listening actively to spoken English in a range of social and academic contexts		